Looking at carotid arteries

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This clinic is designed to help you to see what the radiologist sees. It is not intended to be a comprehensive discussion of a given condition, but a guide to the radiological features.

Case presentation

The images in this presentation are from different patients. Some patients were neurologically asymptomatic; others were suffering from neurological symptoms (e.g. transient ischaemic attack, cerebrovascular accident).

Modalities

The principal modality currently used for initially assessing the carotid arteries is ultrasound. With the latest CT technology (multislice scanning) CT angiograms can be performed, but more work needs to be done before this technology plays a significant role. (MRI is also showing some promise in this field.) Traditional angiography is not a first-line investigation.

Background

Dopper ultrasound is a means of detecting movement, which means that it can detect blood moving within vessels.

Depending on the degree of pathology, multiple variations in the Doppler waveform may be seen.

Preparation

No preparation is necessary for ultrasound. (Multislice CT scanning requires administration of contrast.)

Technique

A skilled sonographer is required, as well as a radiologist well versed in vascular ultrasound. The external, internal and common carotid arteries are examined thoroughly (particularly in the vicinity of any stenoses), as well as the vertebral artery. Each artery is examined in real-time in B mode, colour Doppler mode and the Doppler artery waveform mode.

Ultrasonic signs

B mode

The vessel is identified. Areas of intimal thickening and plaque are noted.

Colour Doppler imaging

This can be used to help distinguish an artery from a vein, determine direction of flow, and easily identify branches of vessels or plaque with similar echogenicity to the vessel lumen (hypoechoic plaque).

Doppler waveform analysis

The external carotid artery has a resistive waveform – a very sharp upstroke, a sharp downstroke, and flow decreasing rapidly in diastole, approaching zero or transiently reversing direction (trace below the baseline). If the temporal region (temporal artery) is tapped with a finger, the resulting force will be transmitted down and the waveform will 'oscillate', confirming that the external carotid artery is being assessed (Figure 1).

The internal carotid artery shows a low resistance waveform. It has a slower and less steep upstroke than the external carotid artery, and flow is noted throughout diastole – the flow remaining above the baseline (Figures 2a and b).

The common carotid artery trace is a combination of both the external and internal carotid artery traces (Figures 3a and b).

The vertebral artery has a low resistive waveform.

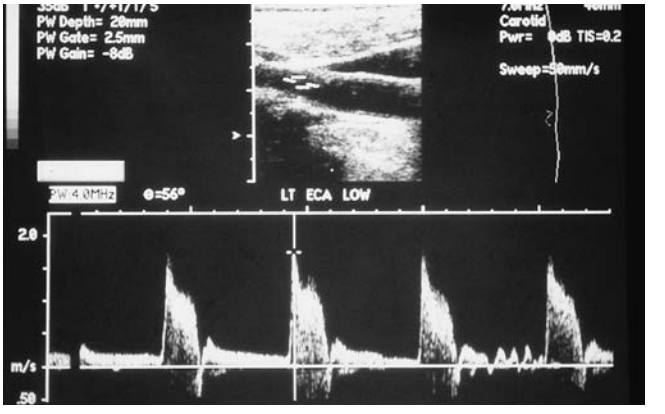

Figure 1. Doppler waveform tracing for the external carotid artery. Note, in this normal image, the high resistance tracing with a sharp upstroke and little flow in diastole. Also note that on the far right the tracing in diastole is oscillating because the temporal artery has been tapped – this helps to confirm it is the external carotid artery.

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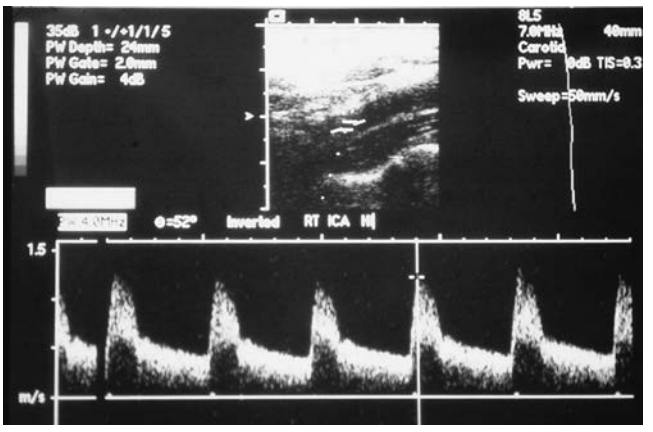
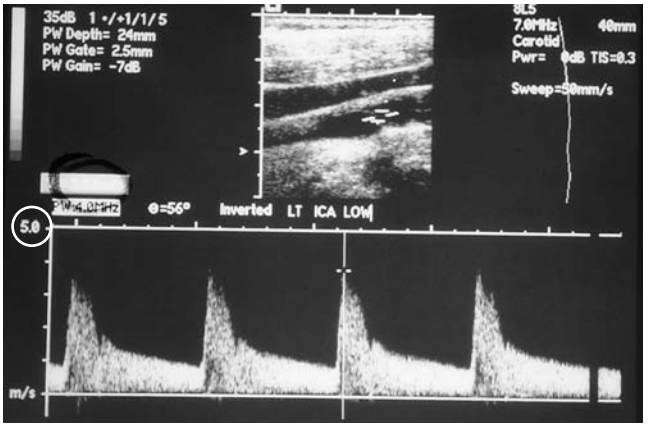
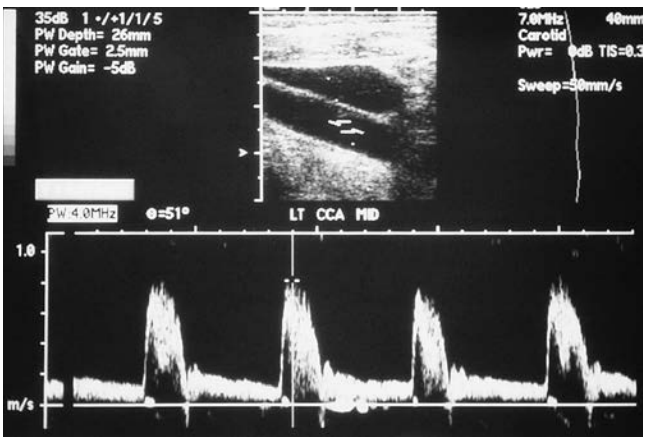
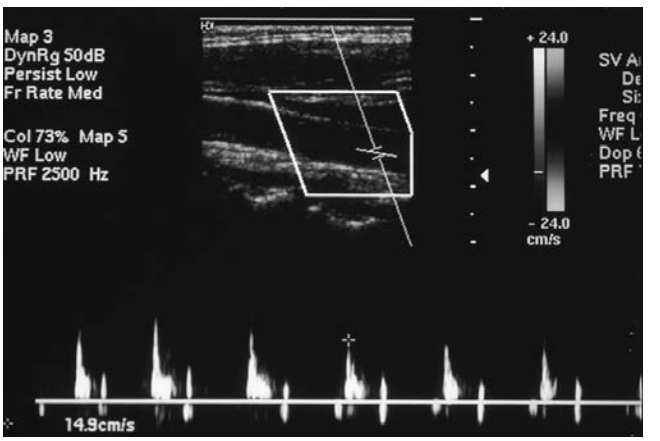




Figures 2a and b. Doppler waveform tracings for the internal carotid artery. a (above left). Normal image. The tracing has a low resistance waveform, with a slow upstroke and continuous flow throughout diastole. b (above right). Abnormal image. Note the very high velocity and spectral broadening consistent with a stenosis.





Figures 3a and b. Doppler waveform tracings for the common carotid artery. a (above left). Normal image. The tracing is a combination of the waveforms of the external and internal carotid arteries. b (above right). Abnormal image. Note the unusual waveform consistent with a severe upstream stenosis.

Classification

When examining the vessel, the following are determined:

- the presence of plaque (Figure 4) and its echotexture (isoechoic, hypoechoic or calcified), surface characteristic (smooth, irregular or ulcerated), size and extent
- the peak systolic and end diastolic velocities
- the velocity ratios (internal:common carotid)
- the waveforms.

Once the above are known, a comment on the degree of stenosis can be made. This should be done by taking into account all of the above factors as well as the clinical picture. Velocities and waveforms are usually considered to be the most important in determining the degree of stenosis, particularly in the internal carotid artery (Figure 5). However, there is

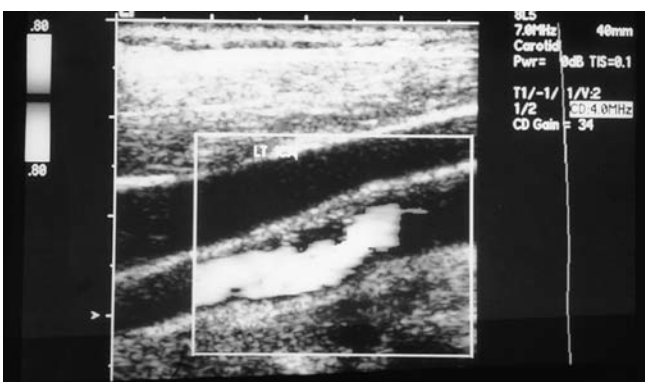


Figure 4. A colour Doppler tracing. Note the isoechoic plaque in the wall, narrowing the lumen.

What the terms mean

B mode
Is a basic, two-dimensional, greyscale image showing the anatomy of the vessels.

Colour flow imaging
Shows real-time flow of the vessel, representing the vessels in colour (blue or red usually) depending upon their direction of flow.

Doppler artery waveform analysis
Gives a graphic representation of flow within the vessel, showing it throughout systole and diastole.

Duplex Doppler
Is a combination of both B mode and Doppler artery waveform assessment, seen on the screen at the same time.

Isoechoic plaque
The plaque has a similar echotexture to the intima or vessel wall.

Hypoechoic plaque
The plaque has a similar echotexture to the vessel lumen (i.e. black).

Heterogenous plaque
The plaque is a mixture of echotextures, usually containing calcium (which appears white) and shadows.

Spectral broadening
The window under the waveform is filled. This can occur when a stenosis is present.

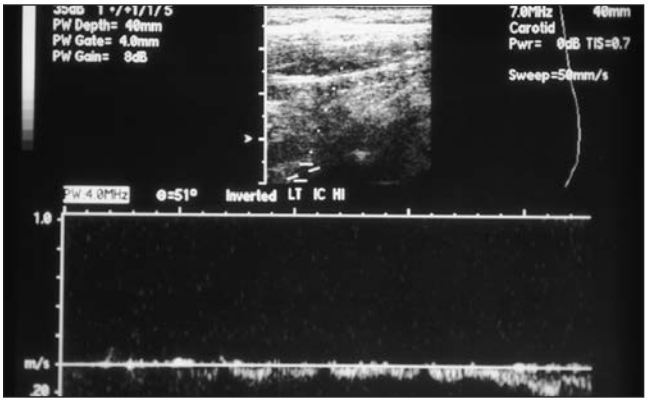


Figure 5. No waveform is demonstrated in this tracing of the internal carotid artery, consistent with occlusion of the vessel.

great variation throughout Australia and around the world as to which velocity corresponds to which degree of stenosis.

Another important factor to be determined is whether the stenosis is haemodynamically significant. Again, opinions differ on this subject (>50 or >70% stenosis – the latter is probably more accepted), and other factors (e.g. the clinical picture) may need to be taken into account.

Key points
Ultrasound is still the principal means of assessing the carotid arteries. It should involve B mode, colour Doppler and Doppler artery waveform assessment. The degree of stenosis is primarily determined by the peak systolic and peak end diastolic velocity, as well as the velocity ratio. MT